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Assessment of the 1989 4WX herring fishery

by

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ABSTRACT

The 1989 4WX herring fishery was dominated by the purse seine sector which accounted for 95% of stock landings. There were some spatial and temporal differences in the pattern of the fishery compared with recent years, including reduced catches from the Trinity Ledge area and increases in the Long Island, Seal Island and upper Bay of Fundy areas. Reported landings were 32% lower than in 1988, mainly due to poor markets, in particular a late price agreement in the roe market. The price dispute also resulted in failure of an experimental test roe purse seine fishery in the Scots Bay area. The 1983 YC (age 6) dominated the stock fishery in numbers and weight for the third successive year while the 1987 YC (age 2) dominated the non-stock N.B. weir and shutoff fisheries. The 1989 larval survey index was 44% lower than the 1988 index, but still the second highest in the 18-yr series. The 1990 acoustic survey estimate of the overwintering aggregation in Chedabucto Bay was 57% lower than the 1989 estimate, but may have been influenced by unusual distribution of the fish. An analytical assessment using a variety of calibration indices for input was considered unreliable and was not used to estimate stock size. Abundance indices indicate that the growth in population size of the 4WX stock in the mid-1980s has ended. The 1983 year-class is still dominant and there does not seem to have been recruitment of an outstanding year-class since. The larval survey recorded an exceptionally high larval abundance in 1988, but it is too early to tell whether these larvae survived to become a strong year-class. In the absence of strong recruitment, a decrease in stock size would be expected as the 1983 year-class diminishes.

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RÉSUMÉ

La pêcherie de harengs en 4WX a été dominée en 1989 par le secteur de la pêche à la senne coulissante qui a été responsable de 95 % des débarquements. On a observé quelques différences spaito-temporelles dans les caractéristiques de la pêche comparativement aux dernières années, parmi lesquelles une diminution des prises dans la région de la chaussés Trinity et une augmentation des prises dans les régions de l'île Long, de l'île Seal et dans la partie supérieure de la baie de Fundy. Les débarquements signalés ont été inférieurs de 32 % à ceux de 1988, principalement à cause des marchés déprimés, en particulier d'une entente tardive sur le prix pour le marché des oeufs. La dispute sur les prix a également entraîné l'échec d'une pêche expérimentale du hareng rogué à la senne coulissante dans la région de la baie Scots. La classe d'âge 1983 (âge 6) a dominé la pêcherie du stock en nombre et en poids pour la troisième année consécutive, tandis que la classe d'âge 1987 (âge 2) a dominé dans le pêcheries fixes et sennes de plage n'appartenant pas au stock du Nouveau-Brunswick. L'indice du relevé larvaire de 1989 a été inférieur de 44 % à celui de 1989, mais arrive quand même au deuxième rang dans la série de données portant sur une période de 18 ans. L'estimation dérivée d'un relevé acoustique de 1990 pour l'aggrégation hivernante dans la baie Chedabucto a été inférieure de 57 % à l'estimation de 1989, mais la distribution inhabituelle du poisson a pu influer sur cette estimation. Une évaluation analytique fondée sur une variété d'indices d'étalonnage a été considérée non fiable et n'a pas été utilisée pour estimer la taille du stock. Les indices d'abondance indiquent que la croissance du stock (taille de la population) de 4WX observée au milieu des années 80 a pris fin. La classe d'âge 1983 est encore dominante et il ne semble pas qu'il y ait eu recrutement d'une classe d'âge exceptionnelle depuis. Le relevé larvaire a permis de constater une abondance larvaire exceptionnellement élevée en 1988, mais il est encore trop tôt pour dire si ces larves ont survécu pour constituer une forte classe d'âge. En l'absence d'un fort recrutement, une diminution de la taille du stock serait à prévoir au fur et à mesure que diminue la classe d'âge 1983.

INTRODUCTION

The 1989 herring fishery in NAFO Div. 4WX was dominated by a purse seine fleet of 40 vessels which accounted for 95% of the (stock) landings. The remaining landings came from approximately 250 weirs, a single midwater trawler, gillnetters, shutoffs, and traps (Table 1). The largest fishery took place on prespawning and spawning aggregations off southwest Nova Scotia (4Xqr; June-October), but there were also major fisheries off southern New Brunswick (4Xs; June-January) and off Cape Breton (4W Chedabucto Bay; October-January) (Fig. 1). The fishery continued to be influenced strongly by markets, but was dominated in 1989 by the adult (fillet) market to domestic processors and and over-the-side sales to foreign vessels, rather than by the roe market (Table 2).

1988 MANAGEMENT PLAN

The 1989 Scotia-Fundy Region Herring Management Plan (Appendix 1) established quotas of 132,450 t for the purse seine fleet and 850 for midwater trawl. In addition, an allowance of 17,900 t was made for catches by "inshore" components (gillnets, Nova Scotia weirs, Nova Scotia traps) for a TAC of 151,200 t. As in previous years, the New Brunswick weir and shutoff fishery, considered to rely on non-stock fish (i.e. Gulf of Maine origin), was excluded from the TAC. The historical summary of TAC, stock catch and total catch is presented in Table 3.

As in 1988, the plan allowed a small experimental roe fishery in the upper Bay of Fundy with the opening date to be determined by roe yield observed in test sets but, because of market problems, this roe fishery did not develop.

In a continuing effort to decrease the fishing pressure on the Trinity Ledge spawning component, the plan imposed intermittent closure of a 100 sq mi area around the Ledge for a total of 18 d during late August and early September.

DESCRIPTION OF THE FISHERIES (SEE TABLE 4)

[I] 4WX "STOCK" FISHERIES

4W (Chedabucto Bay, Winter) Purse Seine Fishery

The 1989 management plan allowed for a fishery of up to 26,490 t (30% of the summer purse seine quota) between Nov. 1, 1988 and Mar. 1, 1989. The reported landings of 6169 t (Table 4) were lower than those of recent years (Table 5) and are believed to reflect market limitation. Log records indicate that fish were readily available and that catch rates were high (Power and Stephenson, 1990). The annual winter acoustic survey documented a large and persistent aggregation of herring in the area (Buerkle, 1989).

4Xs (Bay of Fundy) Fall and Winter Purse Seine Fishery

The fall portion of this fishery on the New Brunswick side of the Bay of Fundy was open from Oct. 15, 1988 to Dec. 31, 1988 with a quota of 9000 t. The winter portion (Jan. 1-Mar. 31, 1989) had a quota of 3000 t. The total recorded landings (5896 t) were lower than in 1988 (Table 4) but similar to recent years and reflect market limitations. Fishermen reported high abundance of fish in the area, and an acoustic survey in February documented approximately 100,000 t of herring (Buerkle 1989).

4Xqr (Southwest Nova Scotia) Summer Fishery

a) Purse seine

The 1989 management plan allowed a fishery between May 1 and Oct. 14, 1989, with a quota of 85,960 t plus any uncaught quota from the fall, winter, Chedabucto Bay and upper Bay of Fundy fisheries. Recorded landings were 68,089 t - a decrease of approximately 30,000 t from 1988. This decrease is thought to reflect market limitations, particularly the absence of a roe fishery until very late in the season due to lack of agreement in the industry on market price. In addition, there was little sardine market for summer purse seine fish due to the success of the New Brunswick weirs (4Xs). Fishermen reported high abundance and catch rates were high in all traditional areas except Trinity Ledge/Lurcher Shoal. Effort was low in these areas and catch rates were also low. Effort and catch expanded in the upper Bay of Fundy (Scots Bay fishery) and there was a considerable increase in the intensity of the fishery off Long Island.

b) Gillnet

The gillnet segment of this fishery recorded only 95 t, the lowest landings on record (since 1963). This continues a steep decline in landings since 1985 which has been primarily the result of an absence of markets.

c) Weirs

Nova Scotia weirs recorded 3308 t, approximately half what was landed in 1987 and 1988. This was the result of limited market, for there were reports of a considerable amount of fish in N.S. weirs in August 1989 that could not be sold.

4Xr Upper Bay of Fundy (Scots Bay) Fishery

The 1989 management plan allowed for a 5000 t roe fishery in the "Upper Bay" (Bay of Fundy north of a line from Cape Spencer, N.B. to Parker's Cove, N.S.) and the fishery was to be opened according to roe yield observed in test vessels. Due to the problems with price negotiations, the roe fishery did not eventuate but approximately 6500 t was taken from the upper Bay of Fundy for other markets.

[2] 4WX "NON-STOCK" FISHERIES

4Xs (New Brunswick) Weir and Shutoff Fishery

The New Brunswick weir and shutoff fisheries recorded 44,112 t (Table 4a, b), an increase of approximately 11,000 t over 1988 and the highest in the last 25 yr. Again, the weirs of Grand Manan Island dominated but considerable landings were made from weirs of Passamaquoddy Bay, Campobello and Deer Islands and along the shore to Saint John. Landings were enhanced by good market conditions for canned sardines.

CATCH STATISTICS

Reported landings for the 1989 fisheries (DFO, Scotia-Fundy Region, Statistics Div. records) are listed by month and gear segment in Table 4, and long-term trends in landings for the major gear segments are presented in Table 5 and Fig. 2. Total recorded landings for the stock in 1989 were 84,463 t, approximately 40,000 (32%) lower than 1988. This decrease is presumed to be due primarily to limited markets, particularly a decrease in the roe market because of a late price agreement within the industry.

ASSESSMENT DATA

STOCK COMPONENTS

As in previous assessments (e.g. Sinclair and Iles 1981; Stephenson et al. 1987), the 4WX fishery is divided into "stock" and "non-stock" components (Table 4). "Stock" fish are considered to belong primarily to the major SW Nova Scotia spawning groups, but this unit also encompasses smaller local stocks (e.g. Grand Manan, Scots Bay). The "non-stock" component is comprised of:

4Xs (N.B.) weirs 4Xs (N.B.) shutoffs	-considered to be migrants from Division 5 stocks
4X miscellaneous	-small localized Nova Scotia South Shore stocks caught in 4Xm gillnet, 4Xm trap and bycatches in handline and longline fisheries
4W miscellaneous	-4W fish taken in gear other than purse seine, on the assumption that the fish are from local stocks.

Also, as in previous assessments, those segments of the fishery which span the winter months (4W and 4Xs purse seine), are considered on a quota year basis (Oct. 15, 1988-Oct. 14, 1989). All other segments are considered for the calendar year 1989.

BIOLOGICAL SAMPLING

As in previous years, sampling of commercial catches was stratified by area, gear segment and month (Hunt 1987) by:

1) obtaining as many length frequencies from individual catches as practical during routine port sampling in N.B. and N.S. and by observers on foreign vessels; and

2) collection of stratified "detail" samples (two fish per half cm size-class above 24 cm; one per half cm size-class at 24 cm and less) to a level of at least 200 fish per area, gear and month.

Sampling in 1989 resulted in 609 length frequencies and 10,667 fish analyzed in detail (including ages) (Table 6).

Biological samples were matched to landings by gear component on a monthly basis as in previous assessments. Numbers at age from commercial catches were generated on the St. Andrews VAX 6210 in the traditional manner, using programs HERNLW02 and HERNAG09. For all gear components, length-frequency samples were applied on a monthly basis. Separate keys were applied for over-the-side (OSS) and domestic markets because of the differences in fish size.

A correction of 2% was applied to length measurements to account for shrinkage due to freezing. This is within the range values observed in several studies in Scotia-Fundy and Gulf Regions summarized by Hunt et al. (1986).

CATCH AT AGE

The age composition of landings in stock and non-stock segments of the fishery is presented in Table 7 and the proportion by age for each fishery in Table 8 and Fig. 3. The 1983 year-class again dominated major stock fisheries in number (27%) and weight (37%). Age 2 fish continued to dominate the non-stock fisheries and age 3 in the 4X fall/winter purse seine on the New Brunswick side of the Bay of Fundy. The historical series of catch at age in number and weight for the 4WX herring fishery (1965-89) are presented in Tables 9 and 10.

LENGTH AND WEIGHT AT AGE

Average weight and length at age has been calculated by gear segment in Table 11 and by month for combined gear types in Table 12. Recent assessments (e.g. Stephenson and Power 1988) have used fishery weighted weights at age (mean for stock fish weighted by gear) and the historical weight-at-age series has been extended in Table 13.

COMMERCIAL CATCH RATES

a) Purse Seine

The detailed purse seine logbook introduced in 1985 (Power and Stephenson 1986, 1987) was used for the fifth consecutive year. Coverage was again high (94% of Statistics Branch landings) as logbook submission remained a condition of license, and information was of similar quality to previous years. 1989 logbook information (Table 14; see also Power and Stephenson, 1990) was used to document various aspects of the Div. 4WX purse seine fishery, including catches by fishing ground, location and total effort on specific components as well as recent patterns of releases. In general, there was a decrease in effort consistent with reduced markets. The logbook data showed a substantial decrease in catch and effort on Trinity Ledge and increases on the Long Island shore, near Seal Island and in the upper Bay of Fundy.

b) Weir Indices

The potential use of weir indices was again reviewed in an evaluation of abundance indices for the 4WX assessment (Stephenson et al. 1990). Weir catch rates suffer from variability in markets and from variable behavior of juvenile herring. Use of the New Brunswick weir series is complicated further by stock mixing. Weir catch/effort series have not been used in this assessment.

RESEARCH SURVEY DATA

a) Larval Abundance

The 1989 larval herring survey was undertaken between Oct. 23 and Nov. 9 (E.E. PRINCE, Cruise P391). All 79 of the traditional larval abundance index stations were sampled. The 1989 index (LAI = 54.5) is approximately 44% lower than the 1988 result - but is still the second highest point in the 18-yr time series (Table 15, Fig. 4; see also Stephenson et al., 1990).

b) Acoustic Survey

An acoustic survey of overwintering herring in Chedabucto Bay was conducted in January 1990 and results are reported by Buerkle (1990). The results of this survey are considerably lower than those of the previous year (Table 16; Fig. 4).

The 1990 acoustic survey of Chedabucto Bay consisted of 23 replicate surveys of the southern portion of Chedabucto Bay. Analysis of seven nighttime surveys resulted in a mean biomass estimate of 193,490 t ($\pm$121,852; 95% CI). This is only 43% of the 450,000 t ($\pm$163,871) reported in 1989. The remaining 12 surveys were done with an uncalibrated transducer after the original was lost at sea and results are not yet available.

The 1990 acoustic estimate is 57% lower than that of 1989. This could indicate either a large decrease in stock size or inadequacy of survey coverage. The additional survey information (after calibration) is unlikely to reduce the difference significantly. Anecdotal information indicates that herring may have left Chedabucto Bay early in 1990. Fishermen claim that herring had been more prevalent in December, but that due to the severe winter, January appeared more like a typical February and that herring had already left the Bay.

c) Groundfish Survey Bycatch

A new index, based upon the bycatch of herring in research groundfish surveys was compiled (Table 17; Stephenson et al., 1990). Surveys of 4WX have been conducted in the past in spring, summer and fall, but only the summer survey has a long and ongoing time series. Herring bycatch was calculated as numbers per standardized tow weighted by stratum (Fig. 4). This index is provisional as there is concern over the low numbers of herring taken in some years, over possible set, vessel and strata effects, and that the peak years in groundfish survey results were offset from those of the larval index.

ESTIMATION OF STOCK SIZE

SPA was undertaken using two formulations of ADAPT (Gavaris 1988). The first formulation (Table 18) combined three indices (larval abundance, acoustic survey and trawl survey). The second formulation used only the larval survey. The ADAPT structure was derived from that attempted in the previous 2 yr using estimates of age 4 population numbers in the most recent year and the slopes of the relationships of each index. The formulation assumes a linear relationship between:

i) larval abundance (year t) and mature biomass (year t + 1) (expressed as fecundity)
ii) acoustic biomass and population biomass, and
iii) summer groundfish survey trawl bycatch of herring (number per standardized tow) and ages 3+ population numbers.

Model residuals (for larval and acoustic indices) were weighted by the inverse of the standard errors. Partial recruitment was calculated from the patterns of F's in recent years (F at age/F ages 5-7 of the previous 3 yr) as in the last assessment. Although the analysis reflects general trends (an increase in population size during the 1980s and recent signs of decline), the model is not refined enough to be specific about stock size.

ASSESSMENT RESULTS AND PROGNOSIS

Abundance indices indicate that the growth in population size experienced in the mid-1980s may have stopped. The 1983 year-class is still dominant and there does not seem to have been recruitment of an outstanding year-class since. The larval survey recorded exceptionally high larval abundance in 1988 but it is too early to tell whether these larvae survived to become a strong year-class. In

the absence of strong recruitment, a decrease in stock size would be expected as the 1983 year-class decreases.

Anecdotal information indicates that very little spawning took place on Trinity Ledge in 1989, and logbook analysis confirms the small amount of catch and effort in 1989 - compared with previous years where as high as 43% of the summer purse seine catch was taken in that area. CAFSAC has previously advised that the pressure on Trinity Ledge had been disproportionately high and that it is important to spread effort among spawning components of a stock complex. Even with low overall fishery pressure it is possible to exert disproportional effort on individual spawning components causing sequential decline.

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Table 1. Landings (t) for gear types involved in the 1985-89 4WX herring fishery.

Gear	1985	1986	1987	1988	1989
Purse seine	101337	67918	91625	114750	80154
Weirs	30786	29470	33408	40072	46783
Gillnet	5584	4318	2919	1151	382
Traps	1304	296	440	1284	123
Shutoffs	1139	371	698	867	637
Midwater trawl	98	28	17	423	783
Miscellaneous	1612	103	74	1329	552
Total	141860	102504	129181	159876	129414

Table 2. Market components of the 4X summer purse seine fishery 1988 and 1989 (from logbook analysis - Power and Stephenson, unpubl. data).

Market	1988 Landings t (logged t)	%	1989 Landings t (logged t)	%
Roe	32,509	38	13268	21
Adult shore	29,361[1]	34	24201	39
Over-the-side	21,755	25	19190	31
Bait	449	1	1950	3
Fillet	410	1	805	1
Sardine[2]	99	0	57	0
U.S. buyers	23	0	64	0
Unspecified	1,135	1	2422	4

[1]Includes a considerable amount of fish which actually went to the roe market.

[2]Sardine market was supplied predominantly by weirs and purse seine landings in other seasons.

Table 3. TAC, reported stock, adjusted stock and total 4WX (stock + non-stock) landings ('000 t).

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
TAC	-	-	-	-	109.0	110.0	99.9	65.0[1]	100.0	80.2	82.0	80.0	125.0	97.6[2]	126.5	151.2	151.2
Reported stock[3] catch	122.7	149.7	143.9	115.2	117.1	95.9	59.0	79.6	87.7	84.7	84.4	78.1	112.4	73.7	101.2	124.6	84.5
Adjusted stock[4] catch						114.0	77.5	107.0	137.0	105.8	117.4	135.9	-	-	-	-	-
Reported total catch	142.6	170.3	174.7	143.9	150.7	134.7	96.2	93.2	106.8	110.7	94.1	88.7	141.9	101.8	130.2	159.9	129.4

[1]TAC raised from 60.0 t to 65.0 t in mid-season.
[2]Excludes an allowance of 13,000 t for inshore 4Xn fixed gear.
[3]Excludes 4Xb weir + shutoff, 4Xn gill + trap, 4W inshore gear.
[4]Includes 1978-1984 adjustment for misreporting and omissions.

Table 4a. Landings (t) by gear component and month for the 1989 4WX herring fishery (data from DFO, Scotia-Fundy Region, Statistics Division).

Gear component	1988 Oct	1988 Nov	1988 Dec	1989 Jan	1989 Feb	1989 Mar	1989 Apr	1989 May	1989 June	1989 July	1989 Aug	1989 Sept	1989 Oct	1989 Nov	1989 Dec	1988 Totals	1989 Totals	1988/89 Totals	Quota Totals
4W Purse Seine		1917	1218	3021	13									3484	3292	3135	9810	12945	6169[1]
4Ia P.Seine	2221								9229	18218	12424	18776	9442			2221	68089	70310	68089[2]
4Ib (NB) Purse	288			2498	2183	927							1311	1456	56	288	8431	8719	5896[1]
4I Gillnet								10	31	34	16	4				0	95	95	95[3]
4I MS Weirs								340	1018	870	854	226				0	3308	3308	3308[3]
4I Traps	56							4	25		43	7	43	1		56	123	179	123[3]
4Ib (NB) Midwater				181	142	460										0	783	783	783[3]
Stock Totals	2565	1917	1218	5700	2338	1387	0	354	10303	19122	13337	19013	10796	4941	3348	5700	90639	96339	84463
4Ib (NB) weirs	6918	2137	43		24		95	37	385	8315	15072	10156	7233	2158		9098	43475	52573	
4Ib (NB) Shutoff	414	125								2	175	69	391			539	637	1176	
4I Misc.	62		1					1	30	77	410	10	22			63	550	613	
4W Gillnet				1	1	1	152	62	6	36	25	2	1			0	287	287	
4W Misc.										2						0	2	2	
Non-stock totals	7394	2262	44	1	25	1	247	100	421	8432	15682	10237	7647	2158	0	9700	44951	54651	
4WI Total all Gears	9959	4179	1262	5701	2363	1388	247	454	10724	27554	29019	29250	18443	7099	3348	15400	135590	150990	
4Vn Purse Seine		1088	1484											296	1782	2572	2078	4650	2078
4Vn Gillnet								23	14	6						0	43	43	
4Vn Trap/Misc.								63	1	4			2			0	70	70	
4VN Totals		1088	1484	0	0	0	0	86	15	10	0	0	2	296	1782	2572	2191	4763	2078
4VWI Overall	9959	5267	2746	5701	2363	1388	247	540	10739	27564	29019	29250	18445	7395	5130	17972	137781	155753	86541

[1]October 1988-March 1989.
[2]January-October 1989.
[3]January-December 1989.

Table 4b. Monthly landings (t) to domestic and OSS (foreign over-the-side sales) markets by gear components involved in the 1989 OSS fishery.

Gear component	1989 Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	1989 Totals
4W Purse Seine Total	3021	13									3484	3292	9810
4W Purse Seine Dom.											2416	760	3176
4W Purse Seine OSS											1068	2532	3600
4Ia P.Seine Total						9229	18218	12424	18776	9442			68089
4Ia P.Seine Dom.						4886	6502	7729	14236	8286			41639
4Ia P.Seine OSS						4343	11716	4695	4540	1156			26450
4I NS Weirs Total					340	1018	870	854	226				3308
4I NS Weirs Dom.								707					707
4I NS Weirs OSS								147					147
4Ib (NB) Weir Total		24		95	37	385	8315	15072	10156	7233	2158		43475
4Ib (NB) Weir Dom.				24		355	6896	11055	7724	6838			32892
4Ib (NB) Weir OSS				71		30	1419	4017	2432	395			8364
4Ib (NB) Shutoff Total							2	175	69	391			637
4Ib (NB) Shutoff Dom.								164					164
4Ib (NB) Shutoff OSS								11					11
Gear Totals	3021	37	0	95	377	10632	27405	28525	29227	17066	5642	3292	125319
Domestic Totals	0	0	0	24	0	5241	13398	19655	21960	15124	2416	760	78578
OSS Totals	0	0	0	71	0	4373	13135	8870	6972	1551	1068	2532	38572

Table 5. Historical series of annual landings (t) for major components of the 4WX herring fishery (1963-88 from Stephenson and Power 1989).

Year	4Wa P.seine	4Xa P.seine	4Xa Gillnet	4Xa Weir	4Xb P.seine	4Xb Shutoff & Weirs	Stock Total *
1963		15093	2955	5345	6871	29366	
1964		24894	4053	12458	15991	29432	
1965		54527	4091	12021	15755	3346	86394
1966		112457	4413	7711	25645	35805	150226
1967		117382	5398	12475	20888	30032	156741
1968		133267	5884	12571	42223	33145	196362
1969	25112	84525	3474	10744	13202	26539	150462
1970	27107	74849	5019	11706	14749	15840	190382
1971	52535	35071	4607	8081	4868	12660	129101
1972	25656	61158	3789	6766	32174	32699	153449
1973	8348	36618	5205	12492	27322	19935	122687
1974	27044	76859	4285	6436	10563	20602	149670
1975	27030	79605	4995	7404	1152	30819	143897
1976	37196	58395	8322	5959	746	29206	115178
1977	23251	68538	18523	5213	1236	23487	117171
1978	17274	57973	6059	8057	6519	38842	95882
1979	14073	25265	4363	9307	3839	37828	59021
1980	8958	44986	19804	2383	1443	13525	79584
1981	18588	53799	11985	1966	1368	19080	87706
1982	12275	64344	6799	1212	103	25963	84733
1983	8226	63379	8762	918	2157	11383	84385
1984	6336	58354	4490	2684	5683	8698	78083
1985	8751	87167	5584	4062	5419	27863	112385
1986	8414	56139	3533	1958	3365	27883	73733
1987	8780	77706	2289	6786	5139	27320	101157
1988	8503	98371	695	7518	7876	33421	124670
1989	6169	68089	95	3308	5896	44112	84463

* Includes all purse seine, 4Xa gillnet, 4Xa weir, 4Xa traps, and 4Xb midwater trawl.

Table 6. Distribution of Biological Samples from the 1989 4WI Commercial Herring Fishery by Area and Month.

Area / Year	Gear Component / Month / Market	Catch		L.F. Samples		L.F. Fish		Detail Samples		Detail Fish		Catch Per Detail Fish	Catch Per L.F. Sample
4W	Purse Seine												
1988	Nov.	1917		12		1985		5		201		9.54	159.75
	Dec.	1218		11		1912		7		320		3.81	110.73
1989	Jan.	3021		18		3545		8		341		8.86	167.83
	Feb.	13	3034	1		248	3793	1	9	45	386	.29	13
	Nov. DOM	2416		3		431		3		124		19.48	805.33
	Nov. OSS	1068		9	12	1623		1	4	48	172	22.25	118.67
	Dec. DOM	760		0		0		0		0			
	Dec. OSS	2532	3292	22	22	4276		4	4	193	193	13.12	115.09
4Iqr	Purse Seine												
1989	Jun. DOM	4886		7		1259		6		227		21.52	698
	Jun. OSS	4343		37		6445		2	8	76	303	57.14	117.38
	Jul. DOM	6502		18		2896		17		586		11.10	361.22
	Jul. OSS	11716		109		19946		12	29	473	1059	24.77	107.49
	Aug. DOM	7729		17		2782		16		588		13.14	454.65
	Aug. OSS	4695		19		3632		0	16	0	588		247.11
	Sept. DOM	14236		7		1087		6		213		66.84	2033.71
	Sept. OSS	4540		10		1628		2	8	81	294	56.05	454
	Oct. DOM	8286		4		609		3		116		71.43	2071.50
	Oct. OSS	1156		6		1023		3	6	121	237	9.55	192.67
4Is	Purse Seine												
1988	Oct.	288		2		325		2		60		4.80	144
1989	Jan.	2498		13		2416		9		256		9.76	192.15
	Feb.	2183		7		1380		6		187		11.67	311.86
	Mar.	927		5		983		3		142		6.53	185.40
	Oct.	1311		1		172		1		28			
	Nov.	1456	2823	1	2	139	311	1	2	26	54	56	1456
	Dec.	56		0		0		0		0			
4I	Gillnet												
1989	May	10		0		0		0					
	Jun.	31		0		0		0					
	Jul.	34	95	0		0		0		<Key from 4I "All Gears" May/Sept.>			
	Aug.	16		15		1500	1500	0		0			1.07
	Sept.	4		0		0		0					
4Ir	Weir												
1989	May	340		1		271		1		11			
	Jun.	1018	1358	4		725	996	4		87	98	11.70	254.50
	Jul.	870		6		1045		6		127		6.85	145
	Aug. DOM	707		9		1406		9		368		1.92	78.56
	Aug. OSS	147	854	0	9	0	1406	0	9	0	368		
	Sept.	226		2		366		2		92		2.46	113

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Table 6, cont'd. Distribution of Biological Samples from the 1989 4WX Commercial Herring Fishery by Area and Month.

Area / Year	Gear Component / Month / Market	Catch		L.F. Samples		L.F. Fish		Detail Samples		Detail Fish		Catch Per Detail Fish	Catch Per L.F. Sample
4X	Trap												
1989	May	4		0									
	Jun.	25	29	0		<Key created from "All Gears" for May/June>							
	Aug.	43		0									
	Sept.	7	50	0		<Key created from "All Gears" for Aug./Sept.>							
	Oct.	43		0									
	Nov.	1	44	0		<Key created from "All Gears" for Sept./Oct.>							
4Xs	Midwater Trawl												
1989	Jan.	181		8		1675		7		236		.77	22.63
	Feb.	142		2		377		2		59		2.41	71
	Mar.	460		5		957		5		113		4.07	92
4Xs	Weir												
1989	Feb.	24		0									
	Apr. DOM	24		0									
	Apr. OSS	71		0									
	May	37	541	1				1		22		1.68	37
	Jun. DOM	355		3	4	991		3	4	48	70	7.40	118.33
	Jun. OSS	30		0				0		0			
	Jul. DOM	6896		38		86278		31		945		7.30	181.47
	Jul. OSS	1419		9	47	1653		1	32	48	993	29.56	157.67
	Aug. DOM	11055		44		7266		42		1350		8.19	251.25
	Aug. OSS	4017		20	64	3551		2	44	111	1461	36.19	200.85
	Sept. DOM	7724		34		5428		29		756		10.22	227.18
	Sept. OSS	2432		7	41	1107		0	29	0	756		347.43
	Oct. DOM	6838		32		5587		21		626		10.92	213.69
	Oct. OSS	395	7233	0	32	0		0	21	0	626		
	Nov. DOM	2158		4		840		4	25	88	714	24.52	539.50
4Xs	Shutoff												
1989	Jul.	2		1		154		1		17		.12	2
	Aug.	175	177	0		0	154	0		0	17		
	Sept.	69		1		180		1		13		5.31	69
	Oct.	391		5		947		5		104		3.76	78.20
4X	Misc.												
1989	May	1											
	Jun.	30											
	Jul.	77											
	Aug.	410				<Included with "4W Gillnet & Misc.">							
	Sept.	10											
	Oct.	22											

... continued

Table 6, cont'd. Distribution of Biological Samples from the 1989 4WI Commercial Herring Fishery by Area and Month.

Area / Year	Gear Component / Month	Market	Catch		L.F. Samples	L.F. Fish	Detail Samples	Detail Fish	Catch Per Detail Fish	Catch Per L.F. Sample
4W	Gillnet & Misc.									
1989	Jan.		1							
	Feb.		1							
	Mar.		1							
	Apr.		152	254						
	May		62							
	Jun.		6							
	Jul.		115	7						
	Aug.		435							
	Sept.		12							
	Oct.		23							
	Nov.		0							
4W	Misc.									
1989	Jul.		2							
4Vn	Purse Seine									
1989	Nov.		296	2078	0	3	438	0	125	14.26	594
	Dec.		1782		3			3	125		
4Vn	Gillnet									
1989	May		23		0					
	Jun.		14		0					
	Jul.		6		0					
4Vn	Trap & Misc.									
1989	May		86	101						
	Jun.		15							
	Jul.		10	12						
	Oct.		2							

(Key created from "All Gears" for May/June)
(Key created from "All Gears" for July)
(Key created from "All Gears" for Aug.)
(Key created from "All Gears" for Sept.)
(Key created from "All Gears" for Oct.)
(Included with "4W Gillnet & Misc.")
(Included with "4Vn Trap & Misc.")
(Key created from "All Gears" 4VWI for May/June)
(Key created from "All Gears" 4VWI for July only)

Table 7. Catch at age in number and weight of stock and non-stock gear components of the 1989 4WX herring fishery.

STOCK

Catch Nos.	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Total
4W Purse Seine	0	1269	6502	5644	5640	9123	5358	1730	1140	591	845	37842
4X Summer P.Seine	0	15267	27329	35415	48514	108614	48874	11315	5021	2275	1470	304094
4X Fall/Winter P.Seine	0	11462	40373	4448	3906	7673	2488	404	94	34	0	70882
4X Gillnet	0	0	0	8	30	139	104	40	16	6	5	348
4X N.S. Weirs	0	29165	4329	1349	2419	3082	1595	452	31	0	9	42431
4X Traps	0	47	53	54	76	191	96	27	11	5	4	564
4X Midwater Trawl	6	20488	8506	288	62	198	20	3	0	0	0	29571
Total Nos. by Age	6	77698	87092	47206	60647	129020	58535	13971	6313	2911	2333	485732

STOCK

Catch Weight (t.)

4W Purse Seine	0	42	469	652	893	1740	1160	436	321	178	279	6169
4X Summer P.Seine	0	880	3240	6165	10542	26737	13880	3558	1687	836	565	68088
4X Fall/Winter P.Seine	0	288	2401	544	625	1414	505	89	21	9	0	5896
4X Gillnet	0	0	0	2	7	36	29	12	5	2	2	95
4X N.S. Weirs	0	995	371	240	450	695	414	130	11	0	3	3308
4X Traps	0	2	6	9	16	47	27	9	4	2	2	123
4X Midwater Trawl	0	324	383	31	9	30	4	1	0	0	0	783
Totals Catch t. by Age	0	2531	6869	7644	12541	30699	16019	4234	2048	1026	850	84462

NON-STOCK

Catch Nos.	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Total
4X N.B. Weirs	24096	317152	80764	21433	22723	43020	11532	3095	810	121	249	524995
4X N.B. Shutoffs	2759	13862	646	9	0	0	0	0	0	0	0	17276
4WX Misc. Gears	0	2052	486	397	439	1408	673	151	47	9	14	5676
Total Nos. by Age	26855	333066	81896	21839	23162	44428	12205	3246	857	130	263	547947

NON-STOCK

Catch Weight (t.)

4X N.B. Weirs	375	13597	8016	3469	4440	9509	2879	829	238	41	82	43474
4X N.B. Shutoffs	46	539	51	1	0	0	0	0	0	0	0	637
4WX Misc. Gears	0	17	53	67	93	345	190	47	16	4	5	838
Totals Catch t. by Age	420	14153	8120	3537	4534	9853	3070	877	254	45	87	44949

Table 8. Proportion (%) catch at age in number and weight for each gear segment of the 1989 4X (stock) herring fishery.

STOCK GEAR COMPONENTS % Numbers at Age	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Totals
4W Purse Seine	0	4	18	15	15	25	15	5	4	2	3	100
4X Summer P.Seine	0	6	9	12	16	36	17	4	2	1	1	100
4X Fall/Winter P.Seine	0	17	57	7	6	11	4	1	1	1	0	100
4X Gillnet	0	0	0	3	9	40	30	12	5	2	2	100
4X N.S. Weirs	0	69	11	4	6	8	4	2	1	0	1	100
4X Traps	0	9	10	10	14	34	18	5	2	1	1	100
4X Midwater Trawl	1	70	29	1	1	1	1	1	0	0	0	100
Overall % by Age	1	16	18	10	13	27	13	3	2	1	1	100

STOCK GEAR COMPONENTS % Catch Weight at Age												
4W Purse Seine	0	1	8	11	15	29	19	8	6	3	5	100
4X Summer P.Seine	0	2	5	10	16	40	21	6	3	2	1	100
4X Fall/Winter P.Seine	0	5	41	10	11	24	9	2	1	1	0	100
4X Gillnet	0	0	1	2	8	38	31	13	6	3	3	100
4X N.S. Weirs	0	31	12	8	14	22	13	4	1	0	1	100
4X Traps	0	2	5	8	14	38	23	7	4	2	2	100
4X Midwater Trawl	1	42	49	5	2	4	1	1	0	0	0	100
Overall % by Age	1	3	9	10	15	37	19	6	3	2	2	100

NONSTOCK GEAR COMPONENTS % Numbers at Age	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Totals
4X N.B. Weirs	5	61	16	5	5	9	3	1	1	1	1	100
4X N.B. Shutoffs	16	81	4	1	0	0	0	0	0	0	0	100
4WX Misc. Gears	0	37	9	7	8	25	12	3	1	1	1	100
Overall % by Age	5	61	15	4	5	9	3	1	1	1	1	100

NONSTOCK GEAR COMPONENTS % Catch Weight at Age												
4X N.B. Weirs	1	32	19	8	11	22	7	2	1	1	1	100
4X N.B. Shutoffs	8	85	9	1	1	0	0	0	0	0	0	100
4WX Misc. Gears	0	3	7	8	12	42	23	6	2	1	1	100
Overall % by Age	1	32	19	8	11	22	7	2	1	1	1	100

Table 9. 4WX herring stock catch at age in numbers (thousands).

	1965	1966	1967	1968	1969	1970	1971	1972
1	270378	154323	722208	164703	108875	699720	87570	0
2	1084719	914093	613970	2389061	290329	576896	404224	649254
3	34835	448940	153626	224956	531812	76532	183896	71984
4	234383	73382	266454	83109	132319	286278	106630	148516
5	49925	321857	110051	290285	162439	201215	113566	77207
6	10592	45916	159203	73087	112631	120280	75593	75384
7	1693	13970	57948	90617	62506	111937	93620	49065
8	561	7722	4497	31977	22595	41257	50022	48700
9	54	1690	409	15441	6345	21271	36618	26055
10	37	215	296	5668	2693	7039	7536	13792
11	1	1	148	1175	722	2674	5695	11679
1+	1687178	1982109	2088810	3370079	1433266	2145099	1164970	1171636
2+	1416800	1827786	1366602	3205376	1324391	1445379	1077400	1171636
3+	332081	913693	752632	816315	1034062	868483	673176	522382

	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	754	14151	2870	240	1164	35381	311	1623	0
2	126421	596153	264491	48470	140494	346719	170523	9566	75713
3	595992	72381	180898	176226	28659	36177	226442	60559	33174
4	109530	616622	92487	130598	192958	11338	47200	359484	68816
5	34422	53199	384646	72334	106061	107627	4639	21958	306716
6	25562	15254	50599	219788	55066	60431	19695	3583	21728
7	19361	8120	9357	18960	150588	27286	15521	3507	1631
8	17604	5313	3238	4967	12466	96741	9981	4951	1914
9	19836	10964	3481	3556	2873	9838	35386	2009	1366
10	9661	5787	2842	1835	1253	2169	3834	8179	361
11	11120	7359	4599	3071	3448	1499	2042	2105	1442
1+	970263	1405303	999508	680045	695030	735206	535574	477524	512861
2+	969509	1391152	996638	679805	693866	699825	535263	475901	512861
3+	843088	794999	732147	631335	553372	353106	364740	466335	437148

	1982	1983	1984	1985	1986	1987	1988	1989
1	3589	3367	0	5762	40	1398	91	6
2	72591	128378	72301	138419	80019	50422	89298	77698
3	122380	101017	141067	215599	176197	76865	68122	87092
4	17756	168379	131251	193369	186983	320651	117398	47206
5	73025	16946	84920	94308	36361	147483	261272	60647
6	154542	41607	13633	27081	20180	27924	142065	129020
7	10910	63468	13803	8989	6878	11843	25594	58535
8	1535	7334	16299	11609	2759	4433	12762	13971
9	977	1351	5418	5107	1879	2043	2519	6313
10	886	434	1263	767	866	1897	2285	2911
11	719	895	5207	300	223	395	1712	2333
1+	458910	533176	485162	701310	512385	645354	723118	485732
2+	455321	529809	485162	695548	512345	643956	723027	485726
3+	382730	401431	412861	557129	432326	593534	633729	408028

Table 10. 4WX herring catch weight (mt) at age.

	1965	1966	1967	1968	1969	1970	1971	1972
1	2704	1543	7222	0	0	0	0	0
2	44473	37478	25173	78122	10800	18288	26719	28762
3	3902	50281	17206	25195	56106	9123	26224	9905
4	40314	12622	45830	12300	21475	48295	21230	28560
5	10884	70165	23991	53587	33657	42376	26132	17333
6	2690	11663	40438	17862	27234	30888	19170	19751
7	484	3995	16573	24983	17627	32708	27403	14302
8	181	2494	1453	12759	6910	13697	16447	15667
9	19	598	145	5216	2117	7840	13256	8989
10	14	84	115	2321	1051	2740	2922	5246
11+	0	0	58	481	282	1041	2208	4443
1+	105666	190923	178203	232827	177260	206996	181710	152958
2+	102962	189380	170981	232827	177260	206996	181710	152958
3+	58489	151902	145808	154704	166460	188709	154991	124196

	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	0	0	0	0	0	0	3	16	0
2	3641	28436	5501	1585	9160	9812	6991	392	3104
3	62996	7976	17059	20107	3247	4055	25362	6783	3715
4	15696	108155	16555	20778	33613	2050	8118	61831	11836
5	7731	10938	82930	16883	22665	24604	1011	4787	66864
6	6429	3659	12124	54815	15099	15627	5003	910	5519
7	5404	2251	2503	5256	44122	8243	4439	1003	466
8	5830	1711	1079	1576	4055	31944	3224	1599	618
9	7139	3754	1246	1360	943	3453	12527	711	484
10	3757	2037	1077	742	521	861	1491	3182	140
11+	4325	2590	1743	1241	1433	595	794	819	561
1+	122948	171509	141816	124343	134859	101245	68964	82033	93309
2+	122948	171509	141816	124343	134859	101245	68960	82017	93309
3+	119307	143073	136315	122758	125699	91433	61969	81625	90204

	1982	1983	1984	1985	1986	1987	1988	1989
1	36	34	0	0	0	17	1	0
2	2976	5263	2713	7313	4400	2539	1856	2531
3	13707	11314	18630	25442	21781	7501	6006	6869
4	3054	28961	25122	39432	34032	48975	18026	7644
5	15919	3694	19418	23516	8704	29294	51108	12541
6	39254	10568	3533	7536	5469	6843	34340	30699
7	3120	18152	3863	2833	2102	3245	7201	16019
8	496	2369	4828	3879	907	1287	3878	4234
9	346	478	1674	1757	677	650	817	2048
10	345	169	460	337	346	664	785	1026
11+	280	348	1895	132	89	138	635	850
1+	79532	81351	82135	112177	78507	101153	124654	84462
2+	79496	81317	82135	112177	78507	101136	124652	84462
3+	76520	76053	79422	104864	74107	98597	122796	81931

Table 11. Average weight (g) and length (cm) at age for stock and non-stock gear components of the 1989 4WX herring fishery.

STOCK GEAR COMPONENTS Average Wt. at Age	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11 +
4W Purse Seine	0	33	72	116	158	191	216	252	281	301	331
4X Summer P.Seine	0	58	119	174	217	246	284	314	336	368	384
4X Fall/Winter P.Seine	0	25	59	122	160	184	203	221	225	260	0
4X Gillnet	0	0	183	207	227	257	281	307	329	346	387
4X N.S. Weirs	0	34	86	178	186	225	259	288	341	0	317
4X Traps	0	45	111	172	213	245	262	313	340	370	393
4X Midwater Trawl	7	16	45	109	145	153	199	188	0	0	0
Average for Stock Gears	7	33	79	162	207	238	274	303	324	353	365
Average Length at Age											
4W Purse Seine	0	17	22	26	29	31	32	33	34	35	36
4X Summer P.Seine	0	20	25	28	30	31	32	34	34	35	36
4X Fall/Winter P.Seine	0	16	21	26	29	30	31	32	32	33	0
4X Gillnet	0	0	29	30	31	32	33	34	34	35	36
4X N.S. Weirs	0	17	23	29	29	31	32	33	34	0	35
4X Traps	0	18	24	28	30	31	32	34	34	35	36
4X Midwater Trawl	10	14	19	25	29	30	32	33	0	0	0
Average for Stock Gears	10	16	22	28	30	31	32	33	34	35	36

NONSTOCK GEAR COMPONENTS Average weight	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11 +
4X N.B. Weirs	16	43	99	162	195	221	250	268	294	342	329
4X N.B. Shutoffs	17	39	80	138	0	0	0	0	0	0	0
4WX Misc. Gears	0	60	110	169	212	245	283	314	344	382	391
Average for nonstock	16	43	99	162	196	222	252	270	296	344	333
Average length											
4X N.B. Weirs	13	18	24	28	30	31	32	33	34	35	35
4X N.B. Shutoffs	13	18	23	26	0	0	0	0	0	0	0
4WX Misc. Gears	0	20	24	28	30	31	32	33	34	35	36
Average for nonstock	13	18	24	28	30	31	32	33	34	35	35

Table 12. Mean weights at age (g) by month for 1989 4WX herring stock and non-stock fisheries (combined gear).

Stock Gears Combined by Month

Age	1988			1989												
	Oct	Nov	Dec	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Year Avg
1	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	7
2	0	0	0	24	24	15	0	0	28	43	64	49	59	0	0	33
3	0	66	71	66	53	51	0	0	108	110	111	136	141	0	0	79
4	135	127	121	114	117	124	0	0	177	177	160	180	181	0	0	162
5	167	170	158	155	158	162	0	0	199	225	207	219	220	0	0	207
6	183	199	195	183	186	187	0	0	242	250	239	250	245	0	0	238
7	211	228	216	209	196	202	0	0	290	287	270	282	289	0	0	274
8	223	259	254	233	217	232	0	0	310	330	303	311	320	0	0	303
9	0	288	268	274	0	175	0	0	379	344	333	335	332	0	0	324
10	0	301	309	291	0	260	0	0	448	371	382	369	357	0	0	352
11+	0	338	329	318	0	0	0	0	313	393	396	377	394	0	0	364

Non-stock gears combined by month

Age	1988			1989												
	Oct	Nov	Dec	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Year Avg
1	0	0	0	0	0	0	0	0	0	3	3	13	14	21	0	16
2	0	0	0	0	0	0	0	0	13	47	46	45	49	44	0	42
3	0	0	0	0	0	0	0	0	36	95	98	99	111	109	0	99
4	0	0	0	0	0	0	0	0	175	174	170	148	158	143	0	162
5	0	0	0	0	0	0	0	0	204	223	210	172	193	165	0	196
6	0	0	0	0	0	0	0	0	243	252	233	189	212	223	0	222
7	0	0	0	0	0	0	0	0	287	283	269	212	251	234	0	252
8	0	0	0	0	0	0	0	0	303	337	305	236	264	203	0	270
9	0	0	0	0	0	0	0	0	407	311	327	256	304	0	0	296
10	0	0	0	0	0	0	0	0	0	376	345	282	410	0	0	343
11+	0	0	0	0	0	0	0	0	320	375	366	260	308	0	0	331

Table 13. Average weights at age for the 4WX herring fishery (stock portion) 1965-89.

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1	10	10	10	0	0	0	0	0	0	0	0	0	0	0
2	41	41	41	33	37	32	66	44	29	48	21	33	65	28
3	112	112	112	112	106	119	143	138	106	110	94	114	113	112
4	172	172	172	148	162	169	199	192	143	175	179	159	174	181
5	218	218	218	185	207	211	230	225	225	206	216	233	214	229
6	254	254	254	244	242	257	254	262	252	240	240	249	274	259
7	286	286	286	276	282	292	293	292	279	277	268	277	293	302
8	323	323	323	399	306	332	329	322	331	322	333	317	325	330
9	354	354	354	338	334	369	362	345	360	342	358	382	328	351
10	389	389	389	410	390	389	388	380	389	352	379	404	416	397
11	389	389	389	410	390	389	388	380	389	352	379	404	416	397

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	10	10	0	10	10	0	0	0	12	13	7
2	41	41	41	41	41	38	53	55	50	21	33
3	112	112	112	112	112	132	118	124	98	88	79
4	172	172	172	172	172	191	204	182	153	154	162
5	218	218	218	218	218	229	249	239	199	196	207
6	254	254	254	254	254	259	278	271	245	242	238
7	286	286	286	286	286	280	315	306	274	281	274
8	323	323	323	323	323	296	334	329	290	304	303
9	354	354	354	354	354	309	344	360	318	327	324
10	389	389	389	389	389	364	440	400	350	341	353
11	389	389	389	389	389	364	440	400	350	371	365

Table 14a. 4WX herring catch (t), 1985-89 and total effort (sonar search hours) by fishery and grounds.

Fishery	Grounds	1985	1986	1987	1988	1989	1985	1986	1987	1988	1989
		Total Catch in Tons					Total Searching in Sonar Hours				
4W	Chedabucto Bay	4216	6871	4468	7319	8062	135	164	181	385	233
4W	Unknown Areas	746	959	1893			17	32	66		
4W	Total	4962	7830	6361	7319	8062	152	196	247	385	233
4Xa	Grand Manan	3584	2984	2217	301	968	184	284	220	27	77
4Xa	Long Island	857	3060	7309	10892	21915	149	292	771	827	2406
4Xa	Trinity	35800	13419	18851	18586	266	2110	1650	1700	1506	97
4Xa	Lurcher	308			2928	18	39	8		162	14
4Xa	Gannet, Dry Ledge	5675	2187	1474	14901	2010	526	203	162	1187	229
4Xa	Seal Island	13745	8894	11560	18947	23420	718	542	1086	1133	1517
4Xa	German Bank	15502	13346	16434	17692	8087	679	873	985	789	644
4Xa	Scots Bay		36	3649	3949	6583		5	256	184	310
4Xa	S.W. Grounds	558	1839	184	181	223	47	175	28	11	26
4Xa	N.B. Coastal		621	138	126	276		33	9	33	1
4Xa	Unknown Area	7294	5240	6443		440	709	452	561		6
4Xa	Total	83323	51626	68259	88503	64206	5161	4517	5778	5859	5338
4Xb	Grand Manan	1332	2814	2135	4197	3240	26	169	125	162	194
4Xb	Long Island		252	215	18			32	10	3	
4Xb	Trinity	94									
4Xb	Seal Island	123									
4Xb	German Bank			66					8		
4Xb	N.B. Coastal	188		966	692	2231			74	27	167
4Xb	Unknown Areas	36	44	16					6		
4Xb	Totals	1773	3110	3398	4907	5471	26	201	223	192	361
4VN	Sydney Bight	3511	4250	1751	2100	1330		26	29	1	11
4VN	Unknown Area		236		68						
4VN	Total	3511	4486	1751	2168	1330		26	29	1	11

Table 14b. 1985-89 4VWX herring purse seine CPUE by fishery and grounds.

Fishery	Grounds	1985	1986	1987	1988	1989	1985	1986	1987	1988	1989
		Catch per hour Searching					Sets per hour searching				
4W	Chedabucto Bay	42	71	39	34	25	.8	1.1	.9	.7	.9
4W	Unknown Areas	143	60	80			2.1	1.2	1.4		
4W	Average	68	69	52	34	25	1.1	1.1	1.1	.7	.9
4Ia	Grand Manan	28	22	19	9	52	.7	.8	.6	.3	1.0
4Ia	Long Island	16	23	14	21	10	.4	.9	.5	.6	.4
4Ia	Trinity	29	11	13	18	9	.7	.4	.5	.5	.5
4Ia	Lurcher	10			29	1	.2			.7	.1
4Ia	Gannet, Dry Ledge	17	31	17	23	10	.5	.9	.6	.5	.5
4Ia	Seal Island	29	20	16	17	18	.6	.6	.5	.5	.5
4Ia	German Bank	30	21	32	35	12	.6	.6	.7	.7	.4
4Ia	Scots Bay		8	25	28	24		.2	.5	.6	.8
4Ia	S.W. Grounds	34	15	12	13	11	.8	.5	.3	.4	.3
4Ia	N.B. Coastal		33	26	5	n/a		.5	.6	.2	n/a
4Ia	Unknown Area	18	18	26		1	.4	.6	.7		.6
4Ia	Average	27	18	20	23	15	.6	.6	.6	.6	.5
4Ib	Grand Manan	43	22	31	29	21	1.3	1.0	.9	.9	.9
4Ib	Long Island		8	54	6			.5	3.0	.3	
4Ib	Trinity										
4Ib	Seal Island										
4Ib	German Bank			9					.3		
4Ib	N.B. Coastal			11	6	13			.4	.5	.5
4Ib	Unknown Area			3					.2		
4Ib	Average	43	20	26	26	18	1.3	.9	.9	.9	.7
4VN	Sydney Bight		55	30	45	56		1.1	.7	1.0	1.0
4VN	Unknown Area										
4VN	Average		55	30	45	56		1.1	.7	1.0	1.0

Table 15. Larval abundance index (LAI) for the 1989 4WX herring assessment.

Year	LAI[1]	SE
1972	9.4	1.8
1973	6.6	1.3
1974	49.5	10.9
1975	8.6	1.8
1976	13.5	2.9
1977	6.3	1.0
1978	4.5	1.8
1979	7.1	2.1
1980	26.2	6.7
1981	2.7	0.4
1982	12.4	2.1
1983	13.1	2.8
1984	12.6	2.1
1985	41.8	7.2
1986	21.3	4.0
1987	31.2	9.3
1988	98.19	22.3
1989	54.5	11.2

[1]Arith. mean of 79 stations as used in the last assessment (Stephenson and Power 1989).

Table 16. Summary of results from January acoustic surveys of Chedabucto Bay (from Buerkle 1989, 1990).

Year	Mean total scattering (m^2 sr^{-1})	Estimated biomass ('000 t)	SE
1984	64,429	208.4	20.5
1985			
1986	129,307	390.5	69.3
1987	170,658	492.1	50.6
1988			
1989	159,741	450.2	71.1
1990	102,308	193.5	49.7

Table 17. An index of herring bycatch (stratified mean number per tow) in summer groundfish research surveys of 4VWX, 1978-89.

Year	Total sets	Stratified mean number/tow	SE
1978	141	0.25	0.23
1979	146	0.45	0.33
1980	145	0.40	0.37
1981	143	1.10	0.98
1982	150	1.12	0.65
1983	144	1.73	0.58
1984	143	6.17	2.65
1985	152	2.44	1.32
1986	176	24.89	22.33
1987	188	40.78	26.01
1988	177	2.28	0.78
1989	170	6.95	1.56

Table 18. Summary of input for assessment of the 1989 4WX herring fishery using the ADAPT method (Gavaris 1988).

Parameters:

- year-class strength; age 4 in 1990
- calibration constants (slopes) of relationships:
  - i) larval abundance (yr t) vs fecundity (yr t+1)
  - ii) acoustic biomass vs population biomass
  - iii) groundfish survey bycatch index vs population 3+ numbers

Structure:

- PR calculated from average F's in previous 3 yr (assuming ages 5-7 = 1)

Input:

- Larval abundance index (18 yr; 1972-89)
- Acoustic biomass (winter) (Jan. 84, 86, 87, 89, 90)
- Groundfish survey (summer) herring bycatch (1978-89)

Objective Function:

- Weighting by inverse of standard error

Summary:

- Number of observations = 35
- Number of parameters being estimated = 4

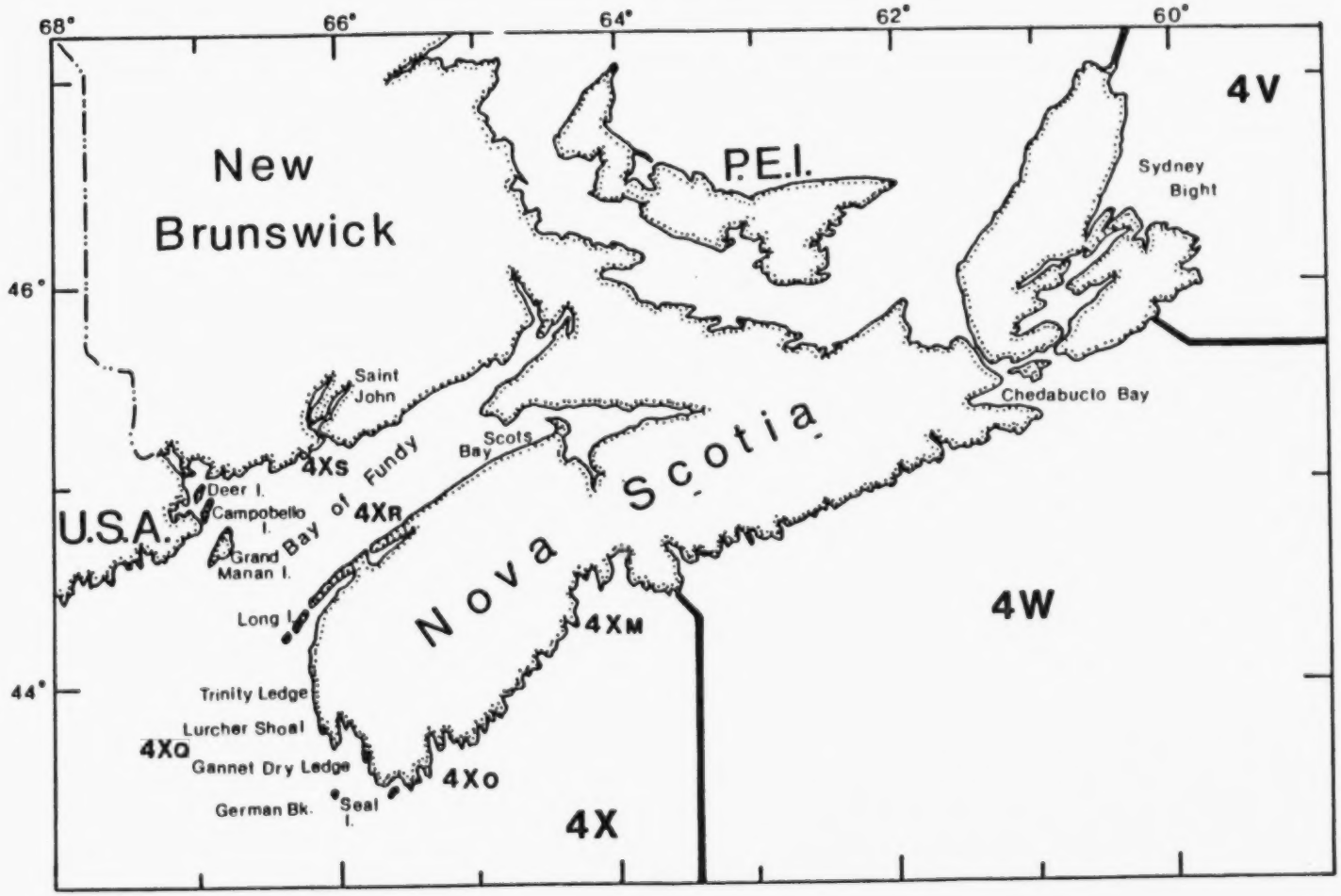

Fig. 1. Map of Div. 4WX showing major locations mentioned in text.

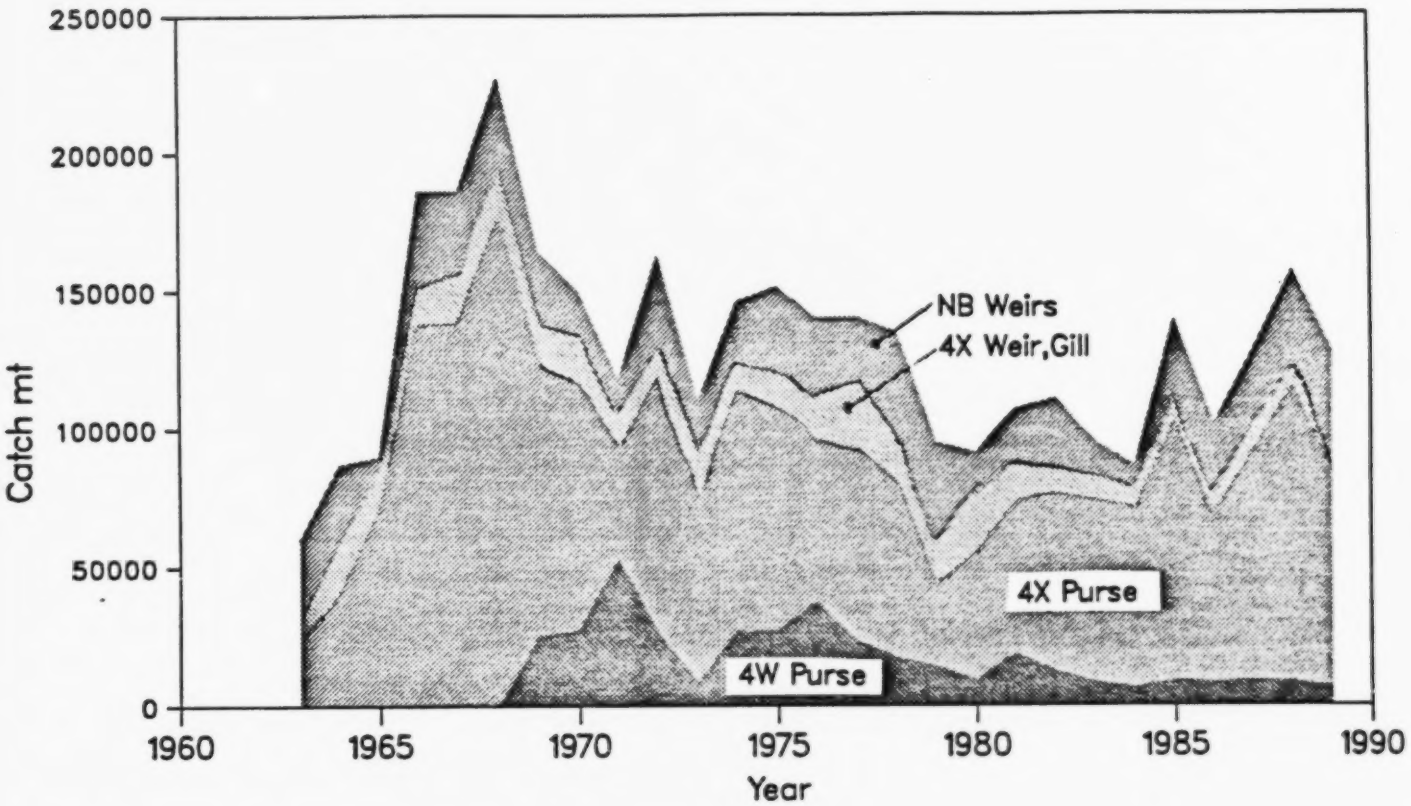

Fig. 2. Historical landings (cumulative) by gear type in the 4WX herring fishery, 1963-89.

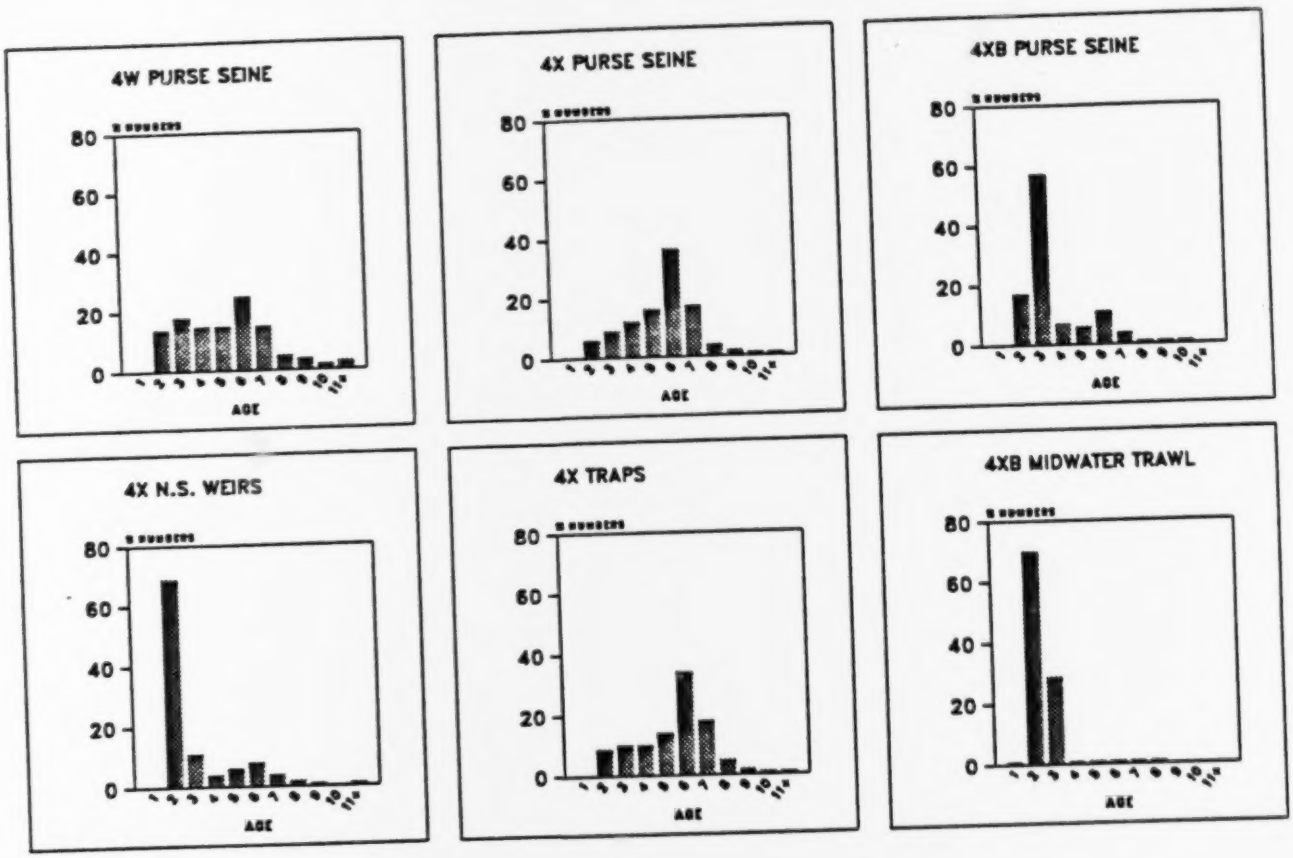

Fig. 3a. Catch at age (% numbers) by gear component in stock portions of the 1989 4WX herring fishery.

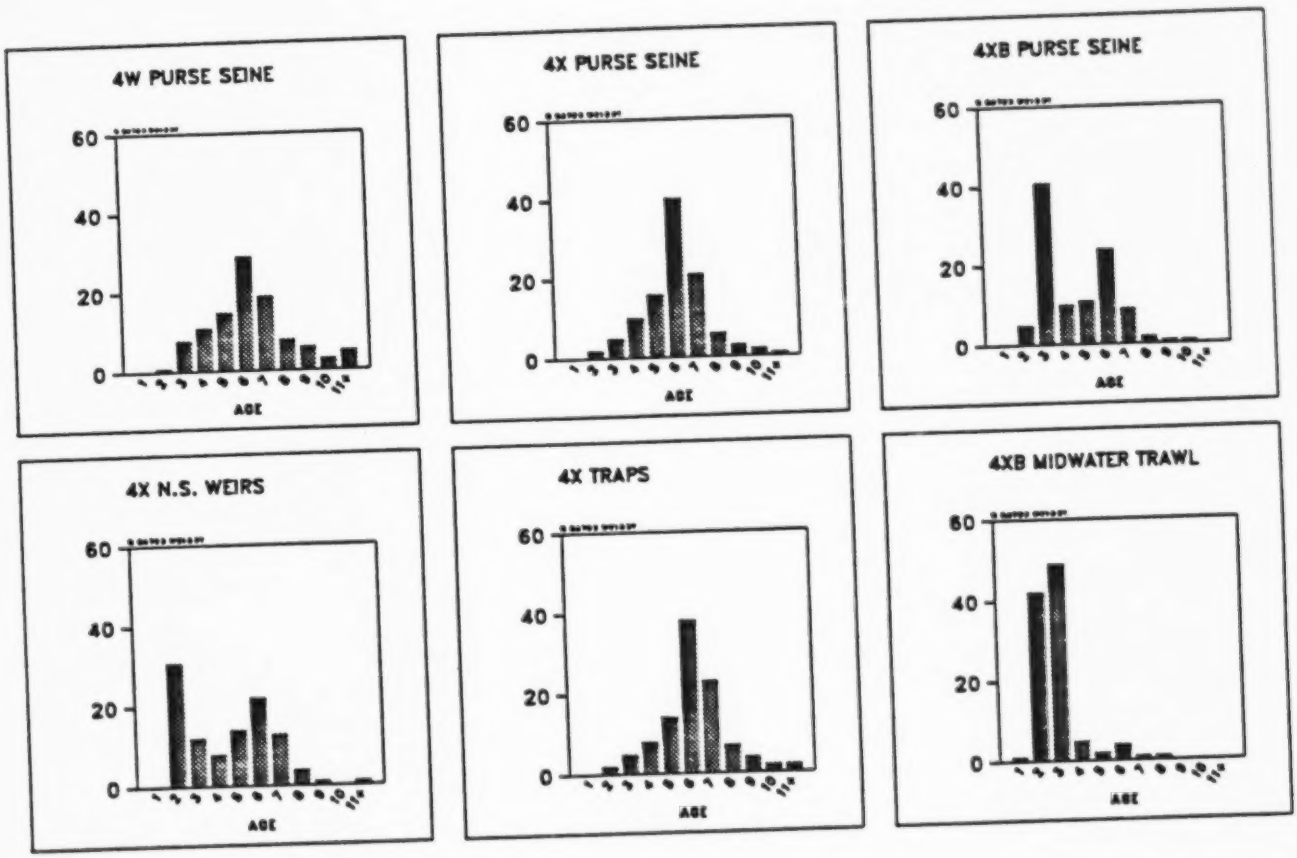

Fig. 3b. Catch at age (% weight) by gear component in stock portions of the 1989 4WX herring fishery.

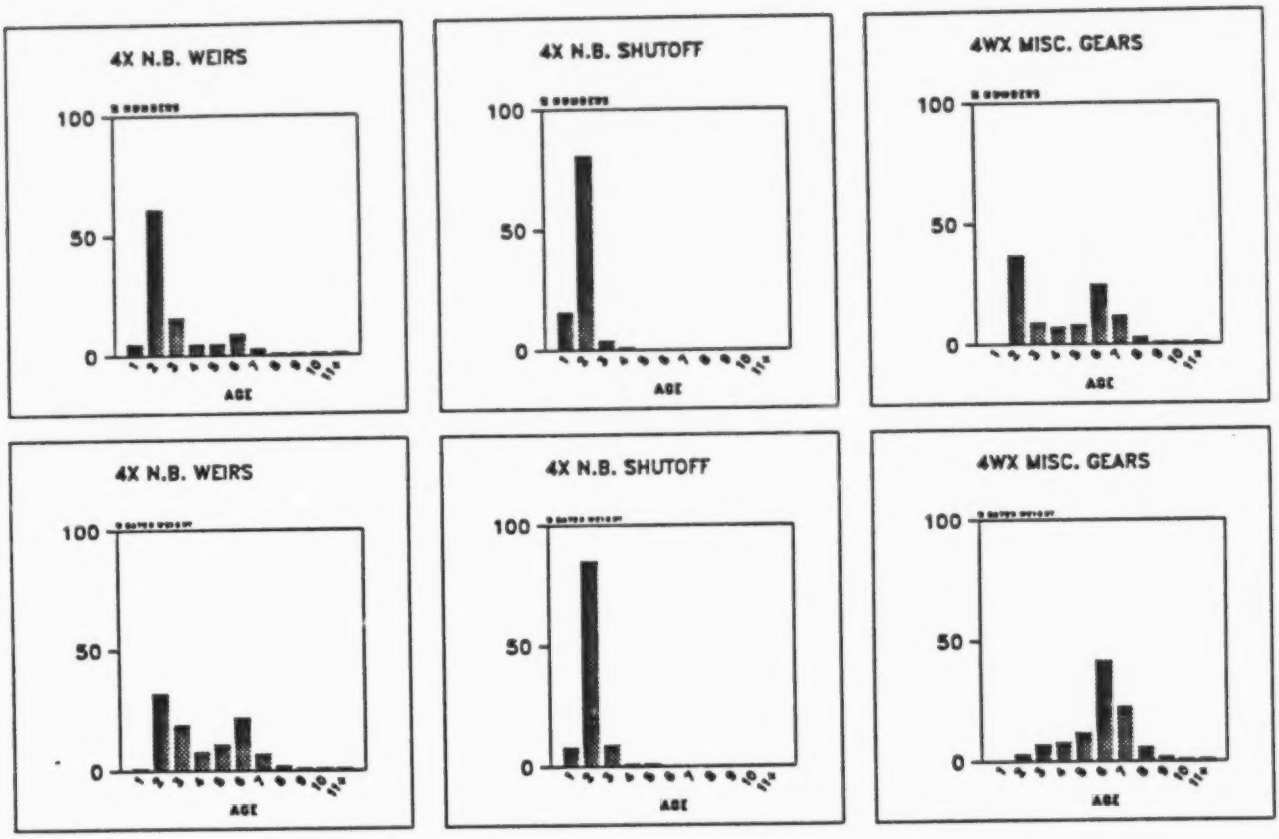

Fig. 3c. Catch at age in number (upper) and weight (lower) in non-stock components of the 1989 4WX herring fishery

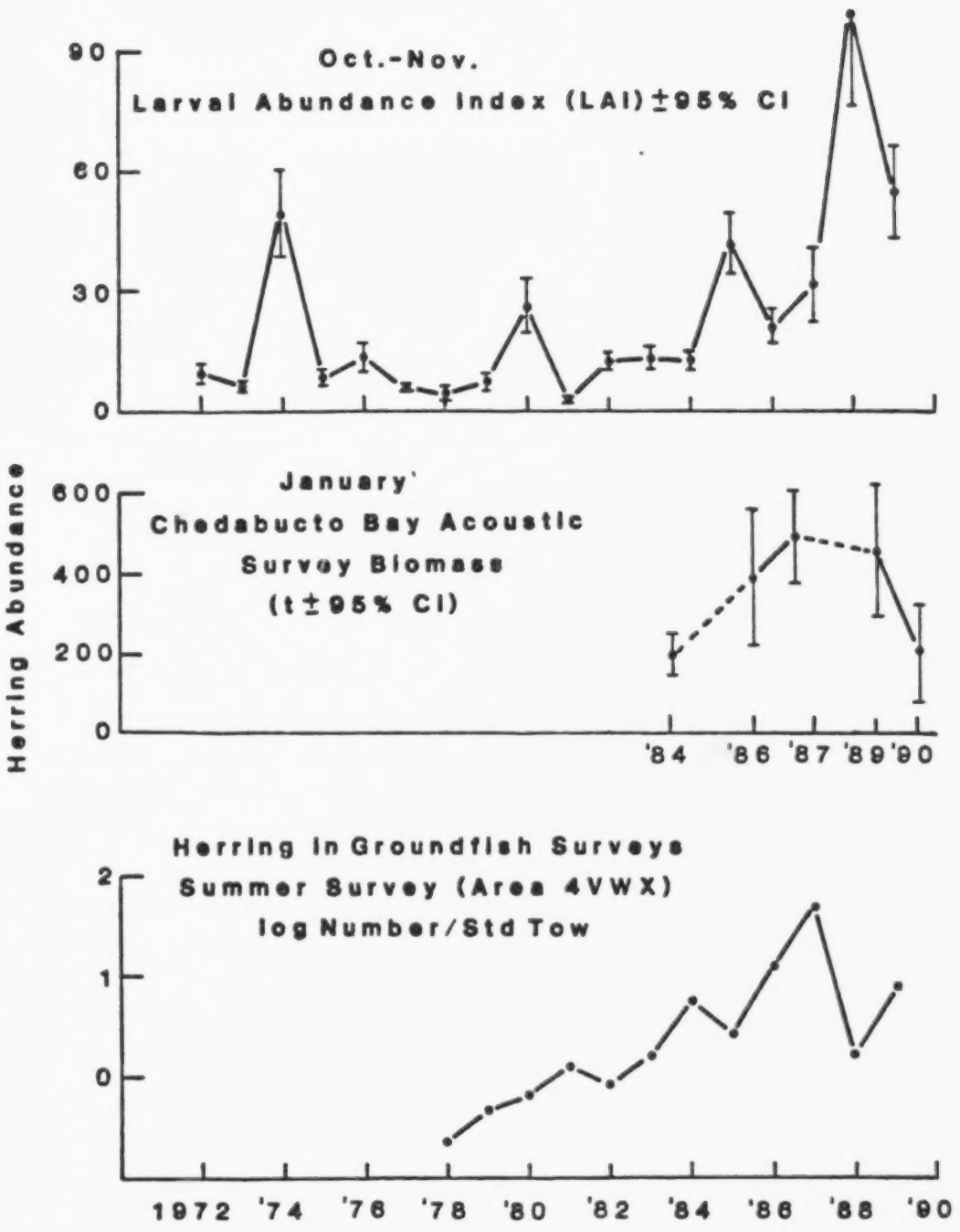

Fig. 4. Abundance indices used in the 4WX herring assessment: (a) larval abundance, (b) acoustic survey, and (c) research bottom trawl.

Appendix I

1989 HERRING FISHERY MANAGEMENT PLAN

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THE 1989 HERRING MANAGEMENT PLAN

1989 HERRING MANAGEMENT PLAN OBJECTIVES

The Scotia-Fundy Herring Advisory Committee (SFHAC) recognizes that the herring stocks have been threaten by overexploitation. Weak stocks, in turn, makes it more difficult to achieve economic stability in the industry. Committee members favour the implementation of effective, long-term conservation and restoration measures. On this front, the 1989 Herring Management Plan stresses the following objectives:

1. Conservation and Restoration

Long-term goals for the 4WX herring fishery are to restore the biomass such that purse seine fishermen harvesting 80 percent of the available TAC can catch 100,000 t. Currently, three good year classes are entering the fishery which, under proper management restrictions on catch, will permit sustained TAC's of 125,000 t. Misreporting, common in the herring fishery, has the potential to retard these long-term management objectives. Given the lack of predictability in pelagic recruitment, the Department of Fisheries and Oceans (DFO) stresses that effective conservation and restoration requires the full cooperation of all industry members. Stability in harvesting patterns will set the stage for long-term economic viability.

2. Fleet Rationalization and Economic Viability

Economic viability for the herring purse seine fleet is a function of quota and price per ton. Closely tied to these factors is the ability of purse seiners to fish the available harvest efficiently. When the ten-year Fleet Reduction Program was introduced in 1983, the purse seine fleet was in a weak state. Many vessels were not cost efficient and many were old and in need of replacement. Currently, several vessels do not have adequate fish holding systems, thereby reducing the quality of landed material. The high cost of financing new vessels has inhibited, in part, the modernization of the large vessel fleet. The small vessel fleet has been modernized more quickly.

The Fleet Reduction Program, through the transfer of quotas, has led to the removal of nine vessels from the fleet. The transfer of quotas has not been fully exhausted; the process of fleet reduction continues. The acquisition of quotas has made some vessels more profitable. In addition, increasing herring prices and TAC levels have put many of the small vessels in a profitable position without the need to acquire additional quotas. DFO and industry remain committed to the 1983 Herring Management Plan and anticipate that the continuous process of fleet rationalization will lead to greater economic viability in coming years. Economic stability should set the stage for reasonable rates of returns on capital investments and on optimal distribution of benefits for participants in the herring fisheries.

3. Improved Utilization of the Resource

The primary market for herring products continues to be sales of roe to Japan though there are strong market opportunities for canned products. Alternative markets exist for frozen fillets and pickled or cured herring but revenues from these sales are modest. Dependency of the roe market results in the dumping of about half the landed herring carcasses on land or at sea. The remaining half is processed into fish meal or into fillets. The current over-the-side sales program provides an opportunity for improved use of the herring catch. The development and use of fish silage as feed may enhance the use of the resource as well.

For the gill net fleet, efforts will continue to improve quality and to develop domestic markets. Until domestic processors again purchase gill net fish, OSS proposals will be supported by the Advisory Committee to provide markets for some sectors of the herring fishery.

4. Elimination of Non-Reported Landings

In recent years, misreporting of landings has been estimated at a lower percentage from traditional levels. Despite this decline, biological advice indicates that any misreporting that moves beyond the approved TAC is worrisome. The new enforcement and regulatory regimes proposed by DFO and industry should impede misreporting efforts.

5. Improved Utilization of the Resource over the Calendar Year

The herring purse seine fisheries operate in the fall 4X and 4W fisheries, the winter 4X and 4W fisheries and the summer 4X fishery. Such fishing patterns supply most processors with sufficient quantities of raw material on a year round basis so that distinct markets can be filled. Herring landed during the different seasons vary in size and type. Different herring products coming out of these seasons can be used to target specific markets.

1989 HERRING FISHING PLAN

Part I

This Plan has been developed in consultation with representatives of the herring fishing industry, the two provincial governments and the Department of Fisheries and Oceans through the Scotia-Fundy Herring Advisory Committee. This Plan will apply to the 1989 herring fishery which begins on October 15, 1988, and ends on October 14, 1989.

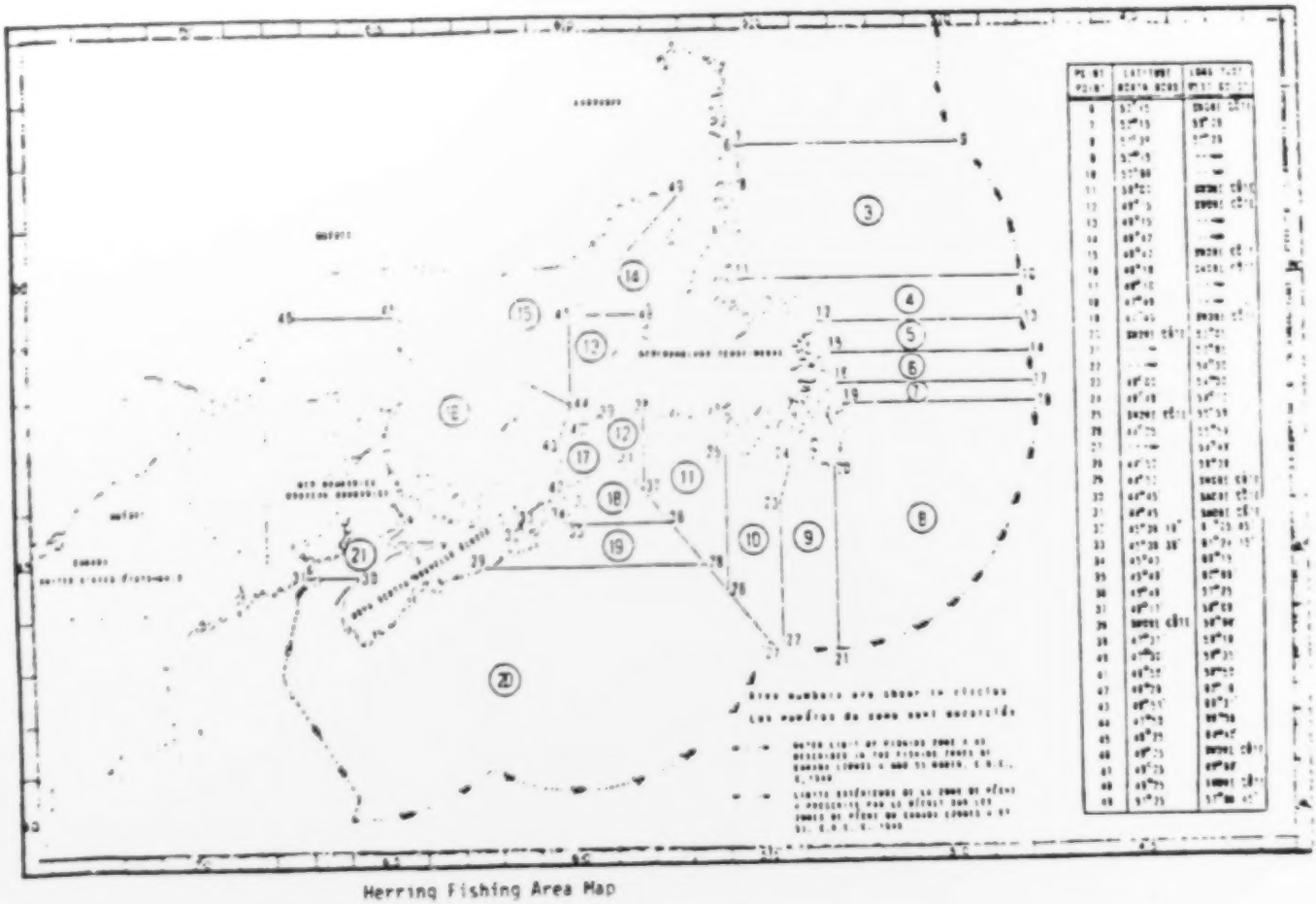
Monitoring of all herring landings will be carried out under the provisions of Section 61 of the Fisheries Act, in accordance with existing regulations and subject to any new regulations which may come into effect in 1989.

1989 SCOTIA-FUNDY HERRING MANAGEMENT PLAN

PART I

The total allowable catch (TAC) will be 4,200 t in Herring Fishing Area 17 for Gulf purse seine vessels and 151,200t in Herring Fishing Areas 19 to 21 for Scotia-Fundy herring fishermen which will be allocated as set out in Table I.

HERRING FISHING AREAS



Herring Fishing Area Map

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1988/89 HERRING FISHING PLAN

GEAR TYPE	FISHERY	AREA	SEASON	QUOTA	FOOT NOTES
PURSE SEINE	FALL	20 & 21	OCT 15 TO DEC 31	9000	
	WINTER	20 & 21	JAN 1 TO MAR 31	3000	1,2
	CHEDABUCTO	AREA 19	NOV 1 TO MAR 1	26490	
	SUMMER	20 & 21	MAY 1 TO OCT 14	85960	3
	SCOTS BAY	AREA 21		5000	4
TOTAL PURSE SEINE VESSEL QUOTAS				129450	
	SCOTS BAY	AREA 21		400	5
	BAIT	19 & 20 & 21		2600	6
TOTAL PURSE SEINE VESSEL QUOTA				132450	
MID-WATER TRAWL	WINTER	20 & 21	JAN 1 TO MAR 31	850	
GILLNETS, TRAPS AND WIERS		17,18,19,20,21		17900	7
TOTAL ALLOWABLE CATCH				151200	
PURSE SEINE	FALL	17	NOV 1 TO MAR 1	4200	8
	FALL	18	CLOSED ALL YEAR	0	

FOOTNOTES TO THE 1988/89 HERRING FISHING PLAN

1. Not more than 500 t of the winter fishery quota will be taken north of a straight line drawn due east from Bliss Island Light, Charlotte County, New Brunswick.

2. The winter quota of 3000 t may be increased by two allotments of 1500 t each unless objections are raised by interested parties DFO will advise when the quota of 3000 t is reached.

3. The quota for the summer fishery will be the balance of any uncaught quotas and over runs from the Fall, Winter, Chedabucto Bay and Upper Bay Fundy fisheries within the 1989 fishery year only.

4. The 5000 t Upper Bay of Fundy quota will be taken north of a straight line drawn between Parker's Cove, Annapolis County, Nova Scotia and Cape Spencer, Saint John County,k New Brunswick. The open season for this fishery will be established after roe quality has been sampled by selected herring purse seine vessels and the Department.

5. A special reserve of 400 t has been set aside for the Upper Bay of Fundy fishery and will be allocated to selected roe testing vessels as compensation for their participation in the testing operation. The 400 t allocation will not count against individual vessel quotas and may be taken after closure of the Upper Bay of Fundy area to the remainder of the fleet.

6. The 2600 t bait quota will be allocated to each purse seiner based on their existing percentage share of the purse seine quota, i.e. 1.6%, 2.7%, etc.

7. Allowances are applied only to the inshore gear licenced for waters adjacent to Nova Scotia. Fixed gear catch by the New Brunswick inshore sector is not considered to be part of the 4VW stock but rather related to NAFO area 5. Therefore, no quotas or allowances are applied by this Plan to inshore gear licenced for the waters adjacent to New Brunswick.

8. To be fished by Gulf purse seiners only, the 4200 t does not count toward the 151,200 t TAC for ther Herring Fishing Area 19 to 21.

PART II

Part II applies to the purse seine fleet.

1. Participation

Any Scotia-Fundy purse seine vessel may participate in any or all of Herring Fishing Areas 19, 20 and 21 subject to season, area quota and vessel quota restrictions.

2. Vessel Quotas

a) All purse seine vessels shall operate on an annual vessel quota. This quota is determined on the basis of a 1.6% share of the TAC for Class A vessels and a 2.7% share of the TAC for Class B vessels.

These percentage shares also apply to processor-owned vessels (Class C) but do not account for quota purchases. Subject to additional authorized quota purchases for the 1989 fishery, individual vessel quotas will be allocated as set out in Table II and issued as a licence condition.

b) All documented individual vessel quota overruns in the 1988 fishery will be deducted from the 1989 individual vessel quotas.

3. Trinity Ledge Closure

The terms of the closure on Trinity Ledge will be reviewed by the Scotia-Fundy Herring Advisory Committee in the spring of 1989. The closure involves that area of Trinity Ledge bounded on the north by latitude 44°05', on the south by latitude 43°55' and on the west by longitude 66°25'.

4. Upper Bay of Fundy

No fishing of herring is permitted north of a straight line drawn between Parker's Cove, Annapolis County, Nova Scotia (Latitude 44°49' and Longitude 65°32') to Cape Spencer, Saint John County, New Brunswick (Latitude 45°12', Longitude 65°55'), until the herring have been sampled by selected purse seine vessels under the supervision of the Department and the area is opened. A special reserve of 400 t has been allocated for the sampling and will not count towards individual vessel quotas or be considered part of the 5,000 t quota for the area. The area will be open to fishing when it is determined that the herring roe sampled is of an acceptable quality.

5. Georges Bank

For the 1989 herring fishing season, Georges Bank will be closed to herring fishing.

6. Over-the-Side Sales (OSS)

Subject to Ministerial approval of the individual arrangements, an over-the-side sales program for 25,000 t of herring may occur for purse seiners.

7. Over-the-Wharf Sales (OTW)

Ministerial approval in principle may be sought, with industry consensus, for an over-the-wharf sales program consistent with government policy, at a later date.

PART III

Part III applies to inshore gear which is comprised of weirs, trap nets and gill nets.

1. General

Effort limitations in all inshore fisheries will be governed by current regulations and licensing policy.

2. Weir Fishery

(a) The Split Rock to Gannet Rock Light closure will be in effect from April 15, 1989, to September 30, 1989. An extension of this closure may be granted up to October 15 after consultation with the affected industry groups, i.e., Connors Brothers, Comeau's Seafoods, South West Seiners, Grand Manan Fishermen's Association, Fundy Weir Fishermen's Association and Atlantic Herring Fishermen's Marketing Co-op.

(b) Subject to Ministerial approval of individual arrangements, an OSS of 5,000 t of herring may occur for weirs. This may be increased if necessary.

3. Herring Drift Net Fishery

a) Subject to Ministerial approval of individual arrangements, an OSS program for 5,000 t may occur. This program will be made up of gill net herring only and no portion of this allowance can be transferred to a purse seine OSS program.

b) Ministerial approval in principle may be sought for an OTW program, consistent with government policy, at a later date.

TABLE II

1989 SCOTIA-FUNDY PURSE SEINE VESSEL QUOTA ALLOCATIONS

CLASS A (NON-MOBILE)	(% SHARE)	CLASS B (MOBILE)	(% SHARE)	CLASS C (PROCESSOR-OWNED)	(% SHARE)
1. CAPE SHOAL	1.6%	25. CANADA 100	4.0%	37. NOVA STAR - non-mobile	1.9%
2 CHELTOM	1.6%	26. CENTENNIAL III	3.0%	38. EASTERN PHOENIX	4.0%
3. CLELAND G.	1.6%	27. DUAL VENTURE	4.0%	39. LADY MELISSA	4.0%
4. CRAIG & DIANE	1.6%	28. EASTERN FISHER	2.7%	40. MATTUNA MARINER	4.0%
5. DAUGHTERS THREE	1.6%	29. ISLAND PRIDE #1	4.0%		
6. FIVE LADIES	3.2%	30. LEROY AND BARRY30. NO. II	4.0%		
7. FLYING SWAN VI	1.6%	31. MARGARET ELIZABETH #1	4.0%		
8. FUNDY MISTRESS	1.6%	32. MARI-LYNNE ANITA	4.0%		
9. GAIL & TROY	1.6%	33. LADY NOREEN	4.0%		
10. GOLDEN DAWN	1.6%	34. PUBNICO GEMINI	2.7%		
11. INGALLS SANDS	1.6%	35. SEALIFE II	4.0%		
12. LISA ANNE	3.2%	36. SEALIFE NO. III	2.8%		
13. MISS JENNIFER	1.6%				
14. NORCHA	1.6%				
15. POLLY B.	1.6%				
16. PUBNICO VIRGO	1.6%				
17. RICHARD B.	1.6%				
18. SARAH & STEWART	1.6%				
19. SEACO	1.6%				
20. SEA FOAM I	1.6%				
21. 7 L'S	1.7%				
22. SEVEN SONS	1.6%				
23. TODD AND CARLA	1.6%				
24. TOMMIE & ARNIE	3.2%				

For 1989, the percentage share of the purse seine TAC and the separate bait quota equates to the following tonnages:

1.6% = 2,070 t and 41.6 t bait
1.7% = 2,200 t and 44.2 t bait
1.9% = 2,460 t and 49.4 t bait
2.7% = 3,495 t and 70.2 t bait
2.8% = 3,625 t and 72.8 t bait
3.0% = 3,883 t and 78.0 t bait
3.2% = 4,142 t and 83.2 t bait
4.0% = 5,178 t and 104.0 t bait

PART IV

Regulatory Requirements

1. Until such time as new regulations can be promulgated to control:

   a) the Trinity Ledge area closure;
   b) the Upper Bay of Fundy closure; and
   c) the 500t limit on herring to be caught north of a line drawn due east from Bliss Island Light in the winter fishery.

   these restrictions can be implemented and legally enforced as licence conditions pursuant to section 33 of the Atlantic Fishery Regulations, 1985.